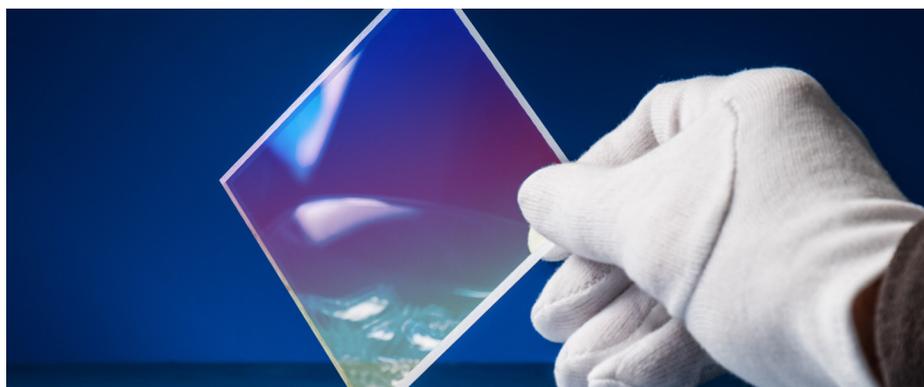


Transmission Measurements of Solid Samples at Variable Angles of Incidence by UV-Vis

Benefits of the Agilent Cary 3500 Flexible UV-Vis spectrophotometer for the characterization of privacy screens



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Cary 3500 Flexible
Sustainable product of the year

Introduction

The accurate characterization of optical materials plays a crucial role throughout applied research, product development, and production—from initial prototype testing to quality control during manufacturing. UV-Vis spectrophotometry is widely used to assess the properties of specialist construction and building materials, mirrors, lenses, filters, optical components for phones, and screens.

The **Agilent Cary 3500 Flexible UV-Vis spectrophotometer** can analyze solid samples using a range of accessories, facilitating efficient material characterization and ensuring optimal performance in a wide variety of applications. In addition to its versatility through the choice of solid sample accessories, the Cary 3500 Flexible can also be equipped with a manual polarizer/depolarizer, enabling comprehensive sample analysis of optical materials.

In this study, a privacy screen designed for an electronic device was analyzed using the Cary 3500 Flexible UV-Vis. The transmission measurements were recorded at varying angles of incidence to examine the effectiveness of the screen in preventing unauthorized viewing of the electronic device.

Experimental

Instrumentation

The Cary 3500 Flexible UV-Vis spectrophotometer (Figure 1) was fitted with a solid-sample holder and a Brewster variable angle holder. In a separate analysis, the Cary 3500 was also fitted with a manual polarizer/depolarizer accessory to control polarization. Details of the accessories are given in Table 1.

Table 1. Accessories for the Agilent Cary 3500 Flexible UV-Vis that were used to measure the privacy screen at variable angles.

Accessory	Illustration	Description
Brewster Angle Holder		The Brewster angle holder measures light transmission at differing angles of incidence onto a thin solid sample. The Brewster angle holder fits into the slide mount of the solid sample holder for the Cary 3500 Flexible UV-Vis.
Manual Polarizer/Depolarizer		Compatible with the slide mount of the solid sample holders of the Cary 3500 Flexible UV-Vis. The manual polarizer holder is compatible with the polarizer and depolarizer elements that easily clip into the holder.



Figure 1. The Agilent Cary 3500 Flexible UV-Vis spectrophotometer includes a large sample compartment and can be fitted with multiple accessories, making it ideal for the characterization of solid samples.

Agilent Cary UV Workstation software was used to set up the UV-Vis method and to run the acquisition of transmission measurements of the commercially available privacy screen.

First, a section of the screen was placed in the Brewster holder and transmission measurements were taken at different angles of incidence using the scan parameters listed in Table 2. Once the spectrum had been acquired, more detailed information could be obtained automatically at the analysis wavelengths of 400, 500, 600, and 700 nm. These wavelengths were saved to the method, as detailed in Table 2.

Polarized measurements at different angles of incidence were then produced by placing the manual polarizer in the rails within the Cary 3500 Flexible UV-Vis module.

Table 2. Agilent Cary 3500 Flexible UV-Vis settings set in the Agilent Cary UV Workstation software.

Parameter	Setting
Collect Mode	Scan
Y-Axis	Transmission (%T)
Wavelength Range (nm)	200 to 700
Analysis Wavelengths (nm)	400, 500, 600, 700
Signal Averaging Time (SAT)	0.1
Spectral Bandwidth (SBW)	5
Data Interval (nm)	1
Slit Height	Full
Baseline	- Depolarized light - s-polarized light (0°) - p-polarized light (90°)
Angles of Incidence	0°, ±10°, ±20°, ±30°

Results and discussion

The Cary 3500 Flexible UV-Vis results for the privacy screen established a clear relationship between the angle of incidence and transmission, as shown in Figure 2. As expected with a privacy screen, as the angle of incidence increased, transmission reduced, preventing viewers at wide angles, e.g., ± 20 to 30°, from seeing through the screen (Figure 2).

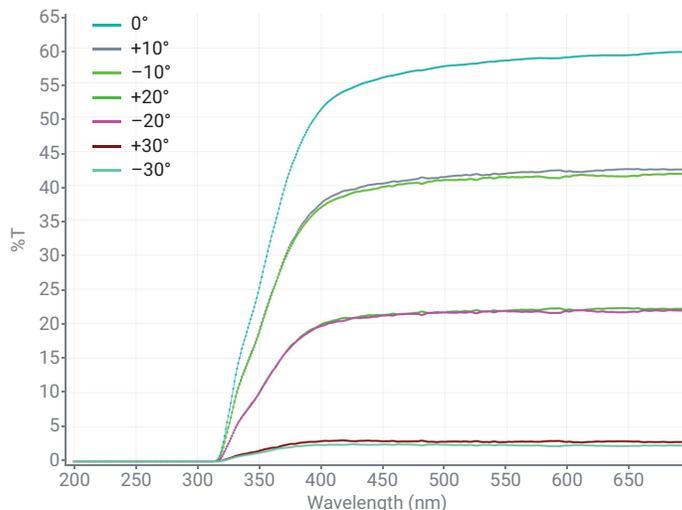


Figure 2. Privacy screen transmission of depolarized light at different angles of incidence.

s- and p-polarized light

The instrument was fitted with the manual polarizer to produce s- and p-polarized light at different angles of incidence. The s- and p-polarized light were compared at an angle of incidence of 20°. The s-polarized light (orange line) returned a lower percentage of transmission compared to p-polarized light (dark blue line) for the full spectrum of wavelengths, as shown in Figure 3. The same angle of incidence was measured using a manual depolarizer (purple line) and the results agreed with the averaged s- and p-polarized data (turquoise line), also shown in Figure 3. The software allows two spectra to be averaged using the built-in calculator.

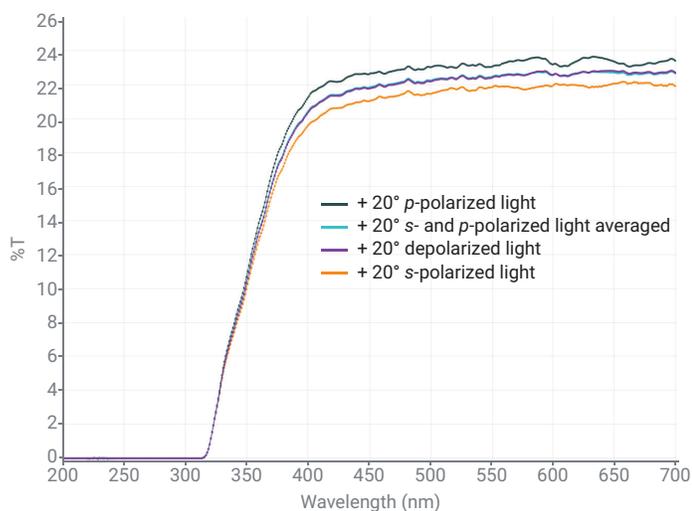


Figure 3. Privacy screen at a 20° angle of incidence at different polarization states: s-polarized, p-polarized, averaged, and depolarized light.

Analysis wavelengths

After data collection, the Cary UV Workstation software enables a thorough analysis of the measurement data. As shown in Figure 4, the %T values of the privacy screen at different wavelengths were easily evaluated, yielding a value at each angle of incidence.

The reliability of the data is due to the xenon (Xe) flash lamp that the Cary 3500 uses as its light source. The high-performance lamp emits monochromatic light at 250 Hz, ensuring fast and precise data acquisition over many years of operation. The robustness of the lamp, as reflected by its 10-year guarantee, reduces the frequency and cost of lamp replacement.

Sample	400.00 nm	500.00 nm	600.00 nm	700.00 nm	Y mode
	Value	Value	Value	Value	
0° AOL_R1	51.10	57.41	58.68	59.46	%T
+10° AOL_R1	37.46	41.31	42.11	42.36	%T
-10° AOL_R1	36.89	40.89	41.41	41.76	%T
+20° AOL_R2	19.87	21.66	22.04	22.15	%T
-20° AOL_R2	19.65	21.66	21.83	21.95	%T
+30° AOL_R2	2.96	2.88	2.86	2.83	%T
-30° AOL_R2	2.42	2.46	2.34	2.35	%T

Figure 4. Automatic wavelength analysis at 400, 500, 600, and 700 nm after data collection.

Tolerance to light

The Cary 3500 Flexible UV-Vis is highly tolerant to room light, allowing users to perform measurements with the sample compartment lid open. The data shown in Figure 5 was acquired both with the sample compartment lid open and closed. The similarity of the %T results at different angles of incidence and at the different wavelengths shows that the system is highly resistant to ambient light interference. Room light tolerance of the Cary 3500 Flexible UV-Vis means that large samples, which prevent the lid from closing, can be measured without compromising data quality.

Sample	400.00 nm	500.00 nm	600.00 nm	700.00 nm	Y mode
 Value	Value	Value	Value	Value	
0 ° AOI	51.10	57.41	58.68	59.46	%T
0 ° AOI Open Lid	51.11	57.42	58.68	59.47	%T
+10 ° AOI	37.46	41.31	42.11	42.36	%T
+10 ° AOI Open Lid	37.47	41.30	42.12	42.36	%T
+20 ° AOI	20.14	21.95	22.34	22.46	%T
+20 ° AOI Open Lid	20.14	21.96	22.33	22.46	%T
+30 ° AOI	2.96	2.88	2.86	2.83	%T
+30 ° AOI Open Lid	2.97	2.88	2.87	2.83	%T

Figure 5. Privacy screen measured at various angles with the sample compartment lid open and closed.

Environmental responsibility

The Cary 3500 Flexible UV-Vis instrument has received My Green Lab's ACT (Accountability, Consistency, Transparency) label, underscoring Agilent's commitment to environmental responsibility. This recognition follows an independent audit, affirming its minimal environmental footprint throughout its operational lifespan.

Conclusion

The Agilent Cary 3500 Flexible UV-Vis system provided comprehensive analysis of a privacy screen at different angles of measurement and with polarized and depolarized light.

The instrument features a large sample compartment that can accommodate a diverse array of accessories as well as a range of different-sized samples. The Brewster angle holder was used in this study to adjust the incident light angles and a polarizer/depolarizer was used to characterize the screen at various angles of incidence.

The Agilent Cary UV Workstation software was used to evaluate the % transmission scan data at selected analysis wavelengths, postanalysis, providing a thorough evaluation of the data. A similar review of the data was conducted to check the effects of room light on the measurement results for the privacy screen. The tolerance of the Cary 3500 to light was confirmed by the similarity of measurements of the sample taken with the sample compartment lid open and closed.

The Cary 3500 Flexible with its large sample compartment provides the flexibility needed for research projects, while ensuring optimal performance for more routine quality control applications.

Further information

- [Agilent Cary 3500 Flexible UV-Vis Spectrophotometer](#)
- [Agilent Cary UV Workstation Software](#)
- [UV-Vis Spectroscopy and Spectrophotometer FAQs](#)

www.agilent.com/chem/cary3500flexible

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